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Research Note 85-77

AD-A160 560

SHOT GROUP ANALYSIS PROGRAM FOR THE M16A1 RIFLE

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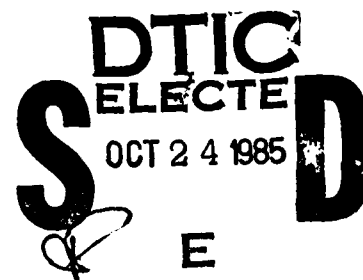


U. S. Army

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July 1985

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARI Research Note 85-77	2. GOVT ACCESSION NO. AD-A160	3. RECIPIENT'S CATALOG NUMBER 580
4. TITLE (and Subtitle)  Shot Group Analysis Program for the M16A1 Rifle	5. TYPE OF REPORT & PERIOD COVERED  July 84 - Jan 85	
	6. PERFORMING ORG. REPORT NUMBER	
7. AUTHOR(s)  Beth W. Thomas, James E. Schroeder	8. CONTRACT OR GRANT NUMBER(s)  NA	
9. PERFORMING ORGANIZATION NAME AND ADDRESS ARI Fort Benning Field Unit P.O. Box 2086 Fort Benning, GA 31905-0686	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS  2Q263743A794 5710 322	
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Research Institute for the Behavioral and Social Sciences, 5001 Eisenhower Avenue Alexandria, VA 22333-5600	12. REPORT DATE July 1985	
	13. NUMBER OF PAGES 16	
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report)  Unclassified	
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE	
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) marksmanship M16A1 rifle ballistics shot group		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This note contains a description of and BASIC program listing for a shot group analysis program for microcomputers. Using this program, target coordinates of individual shots are entered and important shot group statistics are calculated (e.g., mean and median radial error from target center and shot group center, standard deviations of X and Y, etc.). These measures can serve as valuable dependent variables in the research and evaluation of weapons, ammunition, and marksmanship training.		

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1 SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

## SHOT GROUP ANALYSIS PROGRAM FOR THE M16A1 RIFLE

### INTRODUCTION

In marksmanship training and evaluation, scientists and trainers are often forced to use crude performance measures such as hit or miss. New technological advances offer the great promise of precise individual live-fire shot location along with any other desired statistical manipulations performed quickly by a computer. This new technology has been named Location of Miss and Hit (LOMAH) and offers tomorrow's scientists and trainers tremendous information gathering, analysis, and storage capabilities. However, LOMAH equipment is not currently available in sufficient quantities to help today's Army's scientists and trainers. Hence, there is a need for a way to quickly assess the quality of marksmanship performance based on input from more traditional methods (e.g., from the distribution and placement of bullet holes in paper targets). The SHOTGROUP program listed in Appendix A provides that capability.

### HOW TO USE THIS PROGRAM

The SHOTGROUP program was written in BASIC on an Apple IIe microcomputer. However, it should be relatively easy to adapt to other microcomputers with BASIC capabilities. The user must provide the X and Y coordinates of the "center of mass" or other aiming point, along with the X and Y coordinates for each individual shot. These coordinates would presumably be taken from actual targets, scorecard representations, simulator scores, or from LOMAH equipment. The coordinate system used can be arbitrary, depending on how the results are to be used. However, it is suggested that the units used on the grid matrix be measured M16A1 sight "clicks." A M16A1 rifle sight click is equal to one minute of angle. For example, if the soldier is firing at 25m scaled targets, then each unit on the coordinate grid would be .28 in. because one minute of angle at 25m is .28 in. If a given shot on a 25m scaled target were 3.5 in. high and 2.8 in. left, then the coordinates for that shot would be  $X = -10$  and  $Y = +12.5$  (using the  $X = 0$ ,  $Y = 0$  origin as the center of the target). Similarly, for a 50 m target each coordinate unit would be .56 in.; for a 75m target each coordinate unit would be .84 in.; etc. A plastic template which is appropriate for 25m targets has been included as Figure 1. This template can be quickly placed over a 25m scaled target. Then, individual shot coordinates can be read, recorded, and/or used as data entries for the computer program listed in Appendix A. Also shown in Figure 1 are three example shot groups. Analyses of these three shot groups are shown in Tables 1-3.

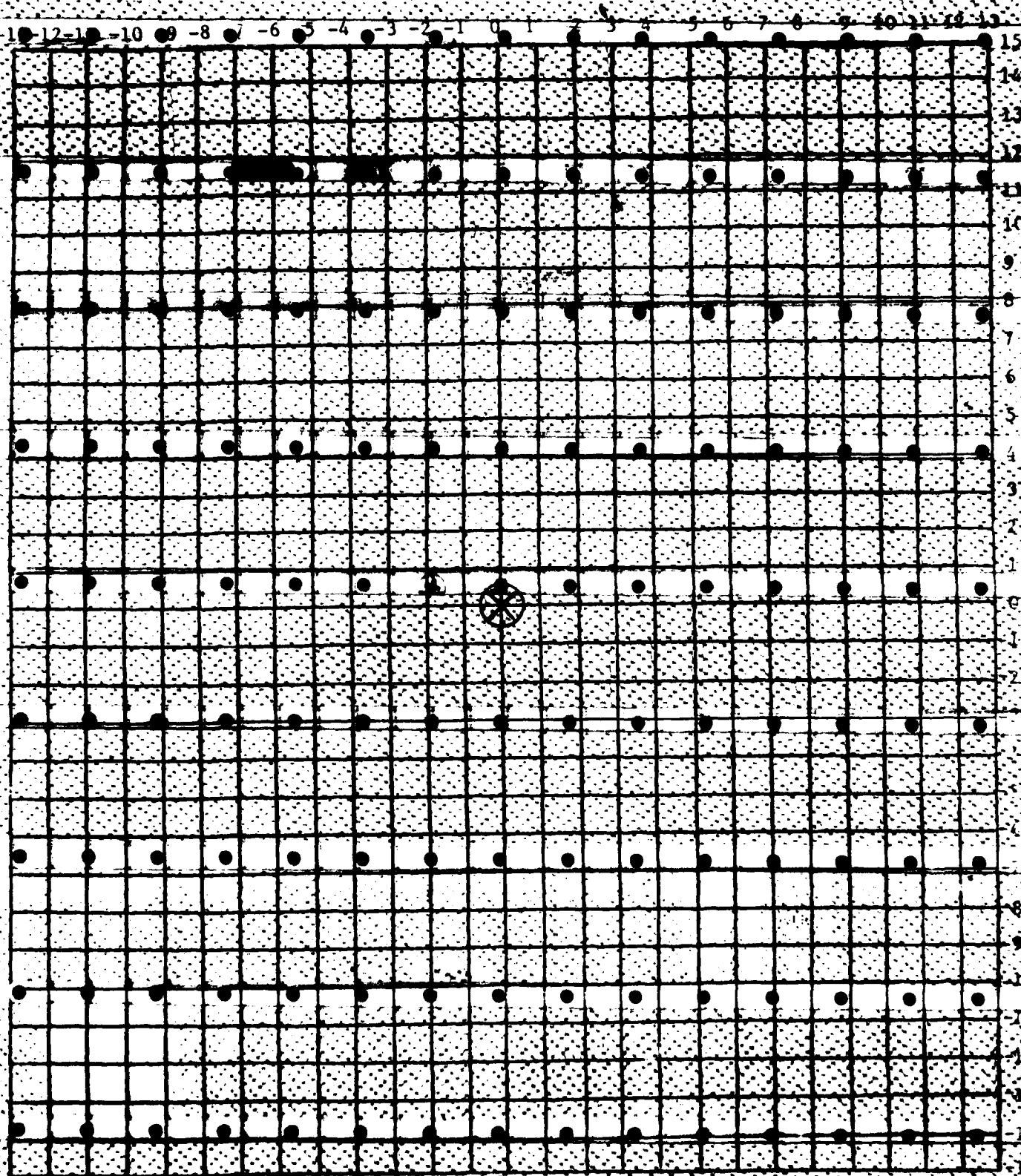
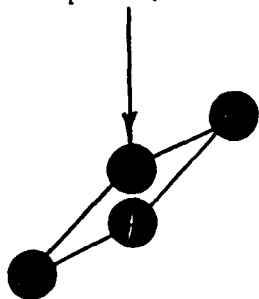
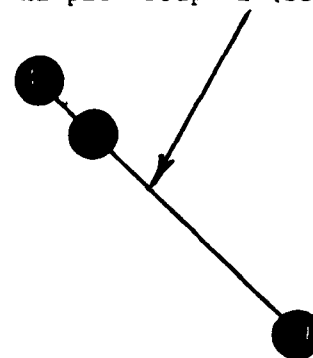


Figure 1. Grid template for collecting gun-scaled silhouette shot location coordinates. Each grid unit equals one minute of angle.

Example Group #2 (see Table 2)



Example Group #1 (see Table 1)



Center of Target



Example Group #3 (see Table 3)

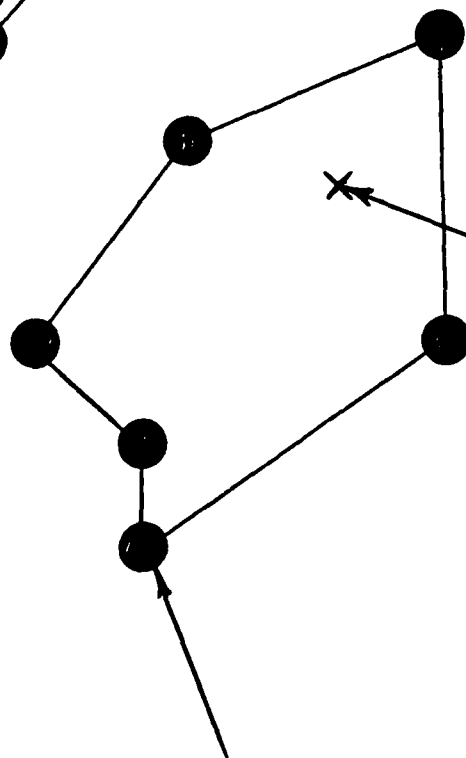


Table 1

Example SHOTGROUP Print-Out #1: Three-Round Group

SUBJECT CODE: 001  
NUMBER OF ROUNDS: 3  
TARGET CENTER OF MASS: (0,0)

SHOT DATA:

SHOT	X	Y	RADIAL ERROR (TARGET CENTER)	RADIAL DISTANCE (SHOT GROUP CENTER)
1	4	7	8.06	2.83
2	9	2	9.22	4.24
3	5	6	7.81	1.41

MEAN X = 6      MEAN Y = 5  
STANDARD DEVIATION X = 2.65      STANDARD DEVIATION Y = 2.65  
SUM OF X AND Y VARIANCES: 14.05

SHOT GROUP DATA:

RADIAL ERROR (TARGET CENTER):      MEAN = 8.36      MEDIAN = 8.06  
RADIAL DISTANCE (SHOT GROUP CENTER):      MEAN = 2.83      MEDIAN = 2.83

COORDINATES OF CENTER OF SHOT GROUP : (6 , 5)  
EXTREME SPREAD (SHOT 1 AND SHOT 2) = 7.07  
DISTANCE OF CENTER OF SHOT GROUP FROM CENTER OF MASS: 7.81  
ANGLE OF SHOT GROUP FROM CENTER OF MASS IN DEGREES: 39.81  
SHOT GROUP CENTER IS LOCATED IN QUADRANT: 1

\*\*\*\*\*

Table 2

Example SHOTGROUP Print-Out #2: Four-Round Group

SUBJECT CODE: 002  
 NUMBER OF ROUNDS: 4  
 TARGET CENTER OF MASS: (0,0)

SHOT DATA:

SHOT	X	Y	RADIAL ERROR (TARGET CENTER)	RADIAL DISTANCE (SHOT GROUP CENTER)
1	-7	4	8.06	.56
2	-9	2	9.22	2.7
3	-6	3	6.71	.9
4	-5	5	7.07	2.3

MEAN X = -6.75      MEAN Y = 3.5  
 STANDARD DEVIATION X = 1.71      STANDARD DEVIATION Y = 1.29  
 SUM OF X AND Y VARIANCES: 4.59

SHOT GROUP DATA:

RADIAL ERROR (TARGET CENTER):      MEAN = 7.77      MEDIAN = 7.57  
 RADIAL DISTANCE (SHOT GROUP CENTER):      MEAN = 1.62      MEDIAN = 1.6

COORDINATES OF CENTER OF SHOT GROUP : (-6.75 , 3.5)  
 EXTREME SPREAD (SHOT 2 AND SHOT 4) = 5  
 DISTANCE OF CENTER OF SHOT GROUP FROM CENTER OF MASS: 7.6  
 ANGLE OF SHOT GROUP FROM CENTER OF MASS IN DEGREES: 152.59  
 SHOT GROUP CENTER IS LOCATED IN QUADRANT: 2

\*\*\*\*\*



Table 3

Example SHOTGROUP Print-Out #3: Six-Round Group

SUBJECT CODE: 003  
 NUMBER OF ROUNDS: 6  
 TARGET CENTER OF MASS: (0,0)

SHOT DATA:

SHOT	X	Y	RADIAL ERROR (TARGET CENTER)	RADIAL DISTANCE (SHOT GROUP CENTER)
1	2	3	3.61	6.77
2	-3	1	3.16	3.43
3	2	-3	3.61	4.22
4	-4	-5	6.4	3.24
5	-6	-3	6.71	3.89
6	-4	-7	8.06	5.02

MEAN X = -2.17      MEAN Y = -2.33  
 STANDARD DEVIATION X = 3.37      STANDARD DEVIATION Y = 3.72  
 SUM OF X AND Y VARIANCES: 25.2

SHOT GROUP DATA:

RADIAL ERROR (TARGET CENTER):      MEAN = 5.26      MEDIAN = 5  
 RADIAL DISTANCE (SHOT GROUP CENTER):      MEAN = 4.43      MEDIAN = 4.06

COORDINATES OF CENTER OF SHOT GROUP : (-2.17 , -2.33)  
 EXTREME SPREAD (SHOT 1 AND SHOT 6) = 11.66  
 DISTANCE OF CENTER OF SHOT GROUP FROM CENTER OF MASS: 3.18  
 ANGLE OF SHOT GROUP FROM CENTER OF MASS IN DEGREES: 227.04  
 SHOT GROUP CENTER IS LOCATED IN QUADRANT: 3

\*\*\*\*\*

The purpose of SHOTGROUP is to provide statistical summary data for a given shot group (e.g., measures of accuracy and dispersion). Hence, the coordinates of at least two shots must be captured and entered into the program. When the program is loaded and run, the user will first be asked to provide some general information:

DO YOU WANT A PRINT-OUT? (Results are sent to the printer or monitor.)

CENTER OF MASS X? (What is the X value at the center of the target?)

CENTER OF MASS Y? (What is the Y value at the center of the target?)

HOW MANY SOLDIERS? (How many shot groups will you be entering?)

The program will next ask for information about a given shot group:

SUBJECT CODE? (Enter identifier for this shot group.)

NUMBER OF ROUNDS? (How many shots in this group?)

SHOT 1 X= (Enter X coordinate for first shot.)

SHOT 1 Y= (Enter Y coordinate for first shot.)

SHOT 2 X= (Enter X coordinate for second shot.)

SHOT 2 Y= (Enter Y coordinate for second shot.)

ETC... (NOTE: Assignment of shot "number" is usually arbitrary.)

After all the shot coordinates are entered, the program will list them and ask the user to indicate whether they are correct. If the user indicates the data are correct, then the program will complete the analysis and print the results. If the user indicates an error, the program will ask which shot data is incorrect and then ask for new coordinates. This correction routine will continue until the user indicates that all the data are correct.

#### PROGRAM OUTPUT

Tables 1-3 show three example shot-group analyses. These three shot groups are shown in Figure 1. The summary data for each shot group consists of:

1. SUBJECT CODE, NUMBER OF ROUNDS, AND COORDINATES OF CENTER OF MASS (The "center of mass" is the same as "center of target.")

2. SHOT COORDINATES, RADIAL ERROR, AND RADIAL DISTANCE for each shot. (NOTE: RADIAL ERROR is defined as the distance from a given shot to the center of the target and should be considered a measure of "accuracy" while RADIAL DISTANCE is defined as the distance of a given shot from the center of the shot group and should be considered a measure of consistency or dispersion.)
3. MEAN X AND MEAN Y FOR THE SHOT GROUP.
4. STANDARD DEVIATIONS OF X AND Y AND THE SUM OF THE VARIANCES OF X AND Y FOR THE SHOT GROUP. (NOTE: These statistics are important marksmanship indices of the consistency or dispersion of the shot group.)
5. MEAN AND MEDIAN RADIAL ERROR (NOTE: These statistics are measures of accuracy, i.e., how close is the shot group to the center of the target?)
6. MEAN AND MEDIAN RADIAL DISTANCE. (NOTE: These measures are important marksmanship indices of consistency or "tightness" of the shot group.)
7. COORDINATES OF THE CENTER OF THE SHOT GROUP (Note: Same as the MEAN X and MEAN Y of the shot group.)
8. EXTREME SPREAD (NOTE: EXTREME SPREAD is often used in marksmanship as a quick index of consistency or dispersion. It is defined as the largest distance between any two shots. In this program, both individual shots are identified and the distance is reported.)
9. DISTANCE OF CENTER OF SHOT GROUP FROM CENTER OF MASS (NOTE: This is an index of "accuracy", i.e., how far the shot group is from the center of the target.)
10. ANGLE OF SHOT GROUP AND QUADRANT. (NOTE: The angle is reported in degrees (0-359) and the QUADRANT follows normal conventions: QUADRANT 1 = 1 to 89 degrees; QUADRANT 2 = 91 to 179 degrees; QUADRANT 3 = 181 to 269 degrees; and QUADRANT 4 = 271 to 359 degrees.)

#### POSSIBLE USES FOR THIS PROGRAM

Given the inherent variability in any person-weapon system, location of a single shot relays relatively little information about performance. However, characteristics of the entire shot group can contain a great deal of information. An excellent marksman must be able to: a) shoot a consistent or "tight" shot group and b) place the center of that shot group on the center of the target or point-of-aim. Of these two, the former is probably a more important measure because in order to obtain a tight shot group, the man/weapon system must show consistency in steady position, trigger manipulation, and point-of-aim. If a person/weapon system is unable to shoot a tight shot group, then there is something wrong with the person/weapon system.

Given proper weapon quality control, the problem can usually be attributed to the person. If a person is able to shoot a tight shot group, but that shot group doesn't fall on the center of the target, then simple sight adjustments can be made to "zero" the weapon. While knowledge about how and when to adjust sights is an important cognitive/mechanical component to marksmanship, it cannot be considered to be the more important measure of marksmanship skill. For this reason, measures of dispersion of the shot group such as STANDARD DEVIATION OF X AND Y, SUM OF THE VARIANCES OF X AND Y, and MEAN OR MEDIAN RADIAL DISTANCE, are often used as dependent measures of marksmanship skill, especially early in training before the person has had an opportunity to adjust sights and zero the weapon.

The use of this program allows scientists and trainers to obtain measures of both "accuracy" (MEAN/MEDIAN RADIAL ERROR) and dispersion (STANDARD DEVIATION OF X or Y, SUM OF X AND Y VARIANCES, and MEAN/MEDIAN RADIAL DISTANCE). These measures can be used by the scientist as dependent variables for correlational or experimental analyses. These measures can be used separately or jointly by the trainer as an index of marksmanship ability. For example, it could be argued that the person/M16A1 system should be capable of placing 70% of the rounds in a 4 cm circle at 25m (4 cm at 25 m is trigonometrically equivalent to the width of an "E" type personnel target at 300 m). Using this criterion, a cut-off value can be calculated and the following rule can be formed: If the STANDARD DEVIATION OF X or Y is greater than 2.7 clicks, then the person should probably receive remediation and/or the weapon should be checked. Also, if the MEAN/MEDIAN RADIAL DISTANCE is much smaller than the MEAN/MEDIAN RADIAL ERROR, then the person needs to adjust sights and zero the weapon.

APPENDIX A

SHOTGROUP Program Listing

# SHOTGROUP PROGRAM

LIST1-450

```

10 REM *** SHOT GROUP ANALYSIS PROGRAM ***
20 REM
30 REM *** ARI RESEARCH PRODUCT ***
40 REM *** BY BETH THOMAS AND JAMES E. SCHROEDER ***
50 REM
60 REM *** THIS VERSION WILL RUN ON AN APPLE II+ OR IIE ***
70 REM *** THE PROGRAM CONDUCTS A SHOT GROUP ANALYSIS FROM INPUT SHOT COORDINATES ***
80 REM *** NOTE: IN THIS PROGRAM, RADIAL ERROR IS DISTANCE FROM A SHOT TO THE ***
90 REM *** CENTER OF THE TARGET AND RADIAL DISTANCE REFERS TO THE DISTANCE FROM A ***
100 REM *** SHOT TO THE CENTER OF THE SHOT GROUP ***
110 REM *****
120 REM
130 PRINT "DO YOU WANT A PRINT-OUT, Y OR N?";P$
140 GET P$
150 DIM X(100),Y(100),RE(100),ROE(100),RD(100),TR(100)
160 REM *****
170 REM *** PRELIMINARY INPUT OF INFORMATION (REMAINS CONSTANT FOR ENTIRE RUN ***
180 REM *****
190 PRINT "CENTER OF MASS X?"
200 INPUT XCM
210 PRINT "CENTER OF MASS Y?"
220 INPUT YCM
230 PRINT "HOW MANY SOLDIERS?"
240 INPUT J
250 REM *****
260 REM *** MAJOR LOOP FOR EACH SHOT GROUP ***
270 REM *****
280 FOR D = 1 TO J
290 PRINT "SUBJECT CODE?"
300 INPUT SC$
310 PRINT "NUMBER OF ROUNDS?"
320 INPUT N
330 IF N > = 2 GOTO 390
340 PRINT "THIS PROGRAM WILL NOT WORK FOR N=1"
350 GOTO 310
360 REM *****
370 REM *** SHOT COORDINATES INPUT AND CORRECTION ***
380 REM *****
390 FOR I = 1 TO N
400 PRINT "SHOT";(I);" X = ": INPUT X(I)
410 PRINT "SHOT";(I);" Y = ": INPUT Y(I)
420 NEXT I
430 FOR I = 1 TO N
440 PRINT "SHOT";(I);" X =";X(I);" Y =";Y(I)
450 NEXT I

```

LIST460-880

```

460 PRINT "ARE THESE CORRECT?"
470 GET PC$
480 IF PC$ < > "N" GOTO 560
490 PRINT "CHANGE WHICH SHOT?": INPUT K
500 PRINT "SHOT";(K);"    X = ": INPUT X(K)
510 PRINT "SHOT";(K);"    Y = ": INPUT Y(K)
520 GOTO 430
530 REM *****
540 REM *** BASIC STATISTICS FOR RADIAL ERROR ***
550 REM *****
560 XSUM = 0
570 YSUM = 0
580 SUMRE = 0
590 FOR I = 1 TO N
600 RE(I) = (((X(I) - XCM) @ 2) + ((Y(I) - YCM) @ 2)) @ .5
610 ROE(I) = RE(I)
620 ROE(I) = ( INT ((ROE(I) + .005) * 100)) / 100
630 XSUM = X(I) + XSUM
640 YSUM = Y(I) + YSUM
650 SUMRE = RE(I) + SUMRE
660 NEXT I
670 MNRE = SUMRE / N
680 MNRE = ( INT ((MNRE + .005) * 100)) / 100
690 MX = XSUM / N
700 MX = ( INT ((MX + .005) * 100)) / 100
710 MY = YSUM / N
720 MY = ( INT ((MY + .005) * 100)) / 100
730 REM *****
740 REM *** DETERMINE MEDIAN RADIAL ERROR ***
750 REM *****
760 FOR I = N TO 2 STEP - 1
770 FOR K = 1 TO N - 1
780 IF RE(K) < RE(K + 1) GOTO 820
790 A = RE(K)
800 RE(K) = RE(K + 1)
810 RE(K + 1) = A
820 NEXT K
830 NEXT I
840 IF N > 2 * ( INT (N / 2)) GOTO 870
850 MEDRE = ((RE(N / 2)) + (RE((N / 2) + 1))) / 2
860 GOTO 880
870 MEDRE = RE((N / 2) + .5)
880 MEDRE = ( INT ((MEDRE + .005) * 100)) / 100

```

LIST890-1350

```

890 REM *****
900 REM *** COMPUTE EXTREME SPREAD ***
910 REM *****
920 LO = 0:HI = 0:EXSP = 0
930 FOR I = 1 TO N - 1
940 L = I + 1
950 FOR J = L TO N
960 DI = (((X(I) - X(J)) ^ 2) + ((Y(I) - Y(J)) ^ 2)) ^ .5
970 IF DI > EXSP GOTO 990
980 GOTO 1020
990 LO = I
1000 HI = J
1010 EXSP = DI
1020 NEXT J
1030 NEXT I
1040 EXSP = ( INT ((EXSP + .005) * 100)) / 100
1050 REM *****
1060 REM *** BASIC STATISTICS FOR RADIAL DISTANCE FROM CENTER OF SHOT GROUP ***
1070 REM *****
1080 SUMSTDY = 0
1090 SDY = 0
1100 M = 0
1110 FOR I = 1 TO N
1120 SUMSTDY = ((X(I) - MX) ^ 2) + SUMSTDY
1130 SDY = ((Y(I) - MY) ^ 2) + SDY
1140 RD(I) = (((X(I) - MX) ^ 2) + ((Y(I) - MY) ^ 2)) ^ .5
1150 TR(I) = ( INT ((RD(I) + .005) * 100)) / 100
1160 M = RD(I) + M
1170 NEXT I
1180 DX = (SUMSTDY / (N - 1)) ^ .5
1190 DX = ( INT ((DX + .005) * 100)) / 100
1200 DY = (SDY / (N - 1)) ^ .5
1210 DY = ( INT ((DY + .005) * 100)) / 100
1220 SDSUM = ((DX ^ 2) + (DY ^ 2))
1230 SDSUM = ( INT ((SDSUM + .005) * 100)) / 100
1240 MRD = M / N
1250 MRD = ( INT ((MRD + .005) * 100)) / 100
1260 REM *****
1270 REM *** DETERMINE MEDIAN RADIAL DISTANCE ***
1280 REM *****
1290 FOR I = N TO 2 STEP - 1
1300 FOR G = 1 TO N - 1
1310 IF RD(G) < RD(G + 1) GOTO 1350
1320 B = RD(G)
1330 RD(G) = RD(G + 1)
1340 RD(G + 1) = B
1350 NEXT G

```



LIST1360-1800

```

1360 NEXT I
1370 IF N > 2 * ( INT (N / 2)) GOTO 1400
1380 MDRD = ((RD(N / 2)) + (RD((N / 2) + 1))) / 2
1390 GOTO 1410
1400 MDRD = (RD((N / 2) + .5))
1410 MDRD = ( INT ((MDRD + .005) * 100)) / 100
1420 REM *****
1430 REM *** DETERMINE DISTANCE, ANGLE, AND QUADRANT OF CENTER OF SHOT GROUP ***
1440 REM *****
1450 DISTX = MX - XCM
1460 DTY = MY - YCM
1470 IF DISTX = 0 AND DTY = 0 GOTO 1600
1480 C = ((DISTX @ 2) + (DTY @ 2)) @ .5
1490 C = ( INT ((C + .005) * 100)) / 100
1500 IF DISTX < > 0 GOTO 1520
1510 T = 0:DG = 0: GOTO 1560
1520 T = ATN ((DTY) / (DISTX))
1530 Q = 0
1540 DG = 57.29578 * T
1550 DG = ( INT ((DG + .005) * 100)) / 100
1560 IF (DISTX < = 0) AND (DTY < = 0) THEN Q = 3: IF Q = 3 THEN DG = 180 + DG
1570 IF (DISTX < = 0) AND (DTY > = 0) THEN Q = 2: IF Q = 2 THEN DG = 180 + DG
1580 IF (DISTX > = 0) AND (DTY < = 0) THEN Q = 4: IF Q = 4 THEN DG = 360 + DG
1590 IF (DISTX > = 0) AND (DTY > = 0) THEN Q = 1
1600 IF (DISTX = 0) OR (DTY = 0) THEN Q = 0
1610 IF ((DISTX > 0) AND (DTY = 0)) THEN DG = 0
1620 IF ((DISTX = 0) AND (DTY > 0)) THEN DG = 90
1630 IF ((DISTX < 0) AND (DTY = 0)) THEN DG = 180
1640 IF ((DISTX = 0) AND (DTY < 0)) THEN DG = 270
1650 REM *****
1660 REM *** PRINT THE RESULTS ON THE MONITOR OR PRINTER ***
1670 REM *** NOTE: TO ADAPT THIS PROGRAM TO OTHER MACHINES, PR#0 AND ***
1680 REM *** PR#1 MUST BE CHANGED TO THEIR APPROPRIATE COUNTERPARTS ***
1690 REM *****
1700 IF P$ < > "Y" GOTO 1720
1710 PR# 1
1720 IF P$ < > "Y" THEN GOTO 1740
1730 GOTO 1750
1740 PRINT : PRINT : PRINT : PRINT : PRINT
1750 PRINT "SUBJECT CODE: ";SC$: PRINT "NUMBER OF ROUNDS: ";N
1760 PRINT "TARGET CENTER OF MASS: "; "(";XCM;"",";YCM;"")"
1770 PRINT : PRINT
1780 PRINT "SHOT DATA:"
1790 PRINT
1800 IF P$ < > "Y" THEN GOTO 1830

```

## LIST1810-

```

1810 PRINT " SHOT";" X ";" Y ";" RADIAL ERROR ";" RADIAL DISTANCE"
1820 GOTO 1850
1830 PRINT "SHOT";" X ";" Y ";" RAD ERR ";" RAD DIST "
1840 GOTO 1860
1850 PRINT TAB( 23);"(TARGET CENTER)";" (SHOT GROUP CENTER)"
1860 PRINT
1870 FOR I = 1 TO N
1880 IF P$ < > "Y" THEN GOTO 1910
1890 PRINT TAB( 4);I; TAB( 6);X(I); TAB( 7);Y(I); TAB( 11);ROE(I); TAB( 17);TR(I)
1900 GOTO 1920
1910 PRINT TAB( 3);I; TAB( 6);X(I); TAB( 9);Y(I); TAB( 14);ROE(I); TAB( 24);TR(I)
1920 NEXT I
1930 PRINT
1940 PRINT
1950 PRINT "MEAN X = ";MX;" MEAN Y = ";MY
1960 PRINT "STANDARD DEVIATION X = ";DX;" STANDARD DEVIATION Y = ";DY
1970 PRINT "SUM OF X AND Y VARIANCES: ";SDSUM
1980 IF P$ < > "Y" GOTO 2000
1990 GOTO 2020
2000 PRINT "TO CONTINUE: HIT ANY KEY"
2010 GET Z$
2020 PRINT : PRINT
2030 PRINT "SHOT GROUP DATA:" : PRINT
2040 PRINT "RADIAL ERROR (TARGET CENTER): MEAN = ";MNRE;" MEDIAN = ";MEDR
2050 PRINT
2060 PRINT "RADIAL DISTANCE (SHOT GROUP CENTER): MEAN = ";MRD;" MEDIAN = ";MDRD
2070 PRINT : PRINT
2080 PRINT "COORDINATES OF CENTER OF SHOT GROUP : (";MX;" , ";MY;")"
2090 PRINT "EXTREME SPREAD (SHOT ";LO;" AND SHOT ";HI;" ) = ";EXSP
2100 PRINT "DISTANCE OF CENTER OF SHOT GROUP FROM CENTER OF MASS: ";C
2110 PRINT "ANGLE OF SHOT GROUP FROM CENTER OF MASS IN DEGREES: ";DG
2120 IF Q < > 0 THEN GOTO 2150
2130 PRINT "THE QUADRANT CANNOT BE DETERMINED"
2140 GOTO 2170
2150 PRINT "SHOT GROUP CENTER IS LOCATED IN QUADRANT: ";Q
2160 IF P$ < > "Y" THEN GOTO 2200
2170 PRINT : PRINT : PRINT
2180 PRINT "*****"
2190 PRINT : PRINT
2200 PRINT
2210 PR# 0
2220 NEXT D
2230 END

```